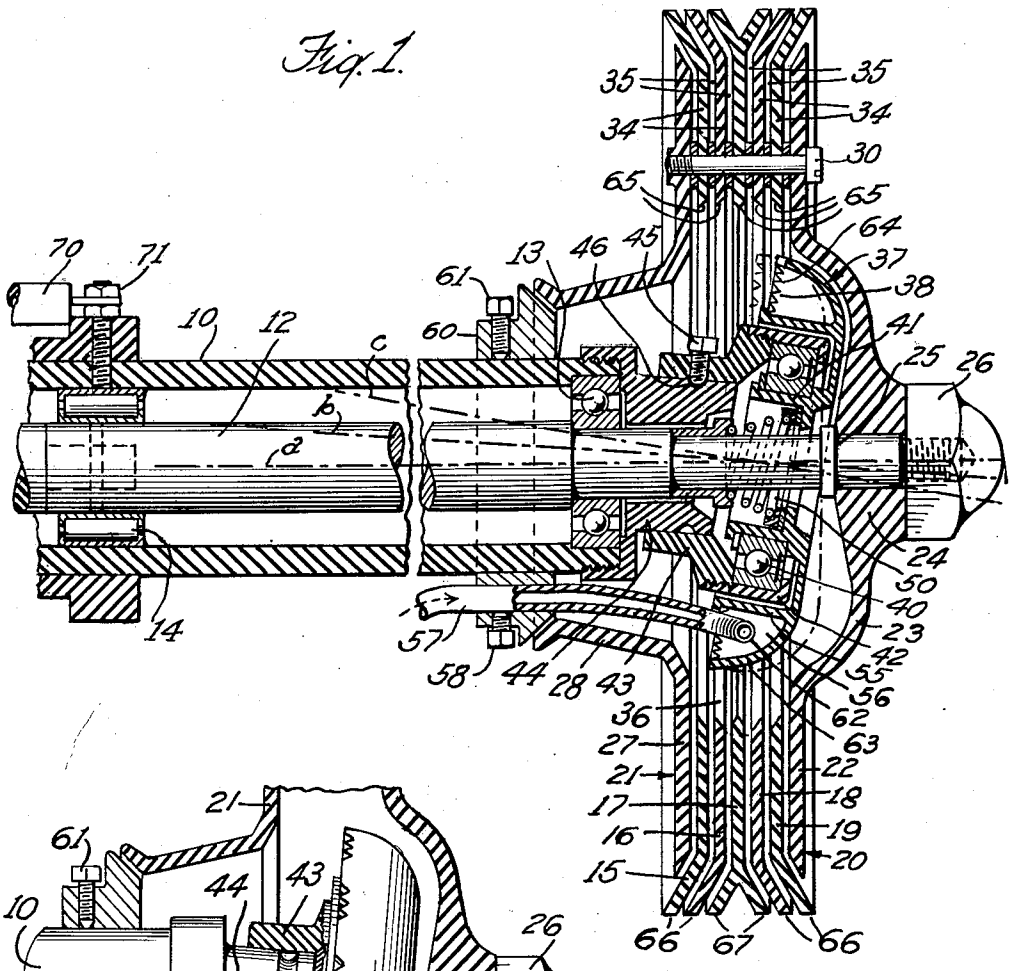
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ELECTROSTATIC SPRAYING DEVICE

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Fig. 1.



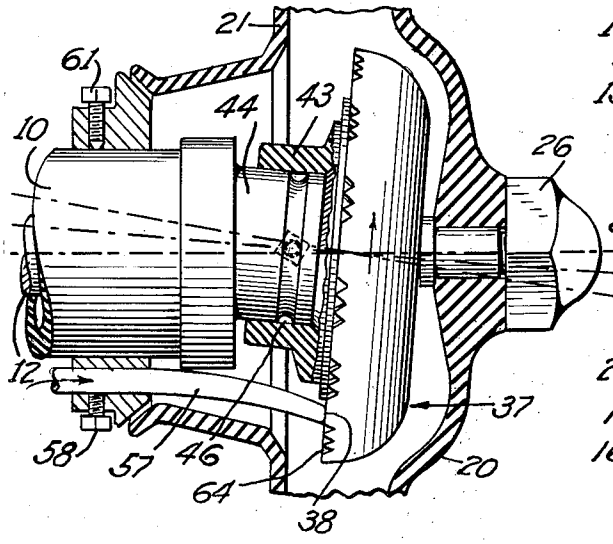


Fig. 2

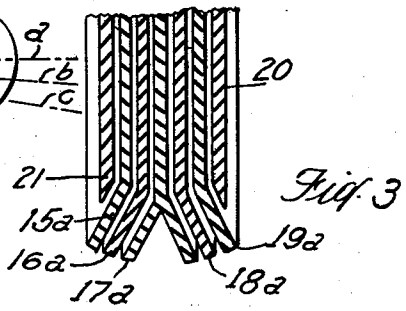


Fig. 3

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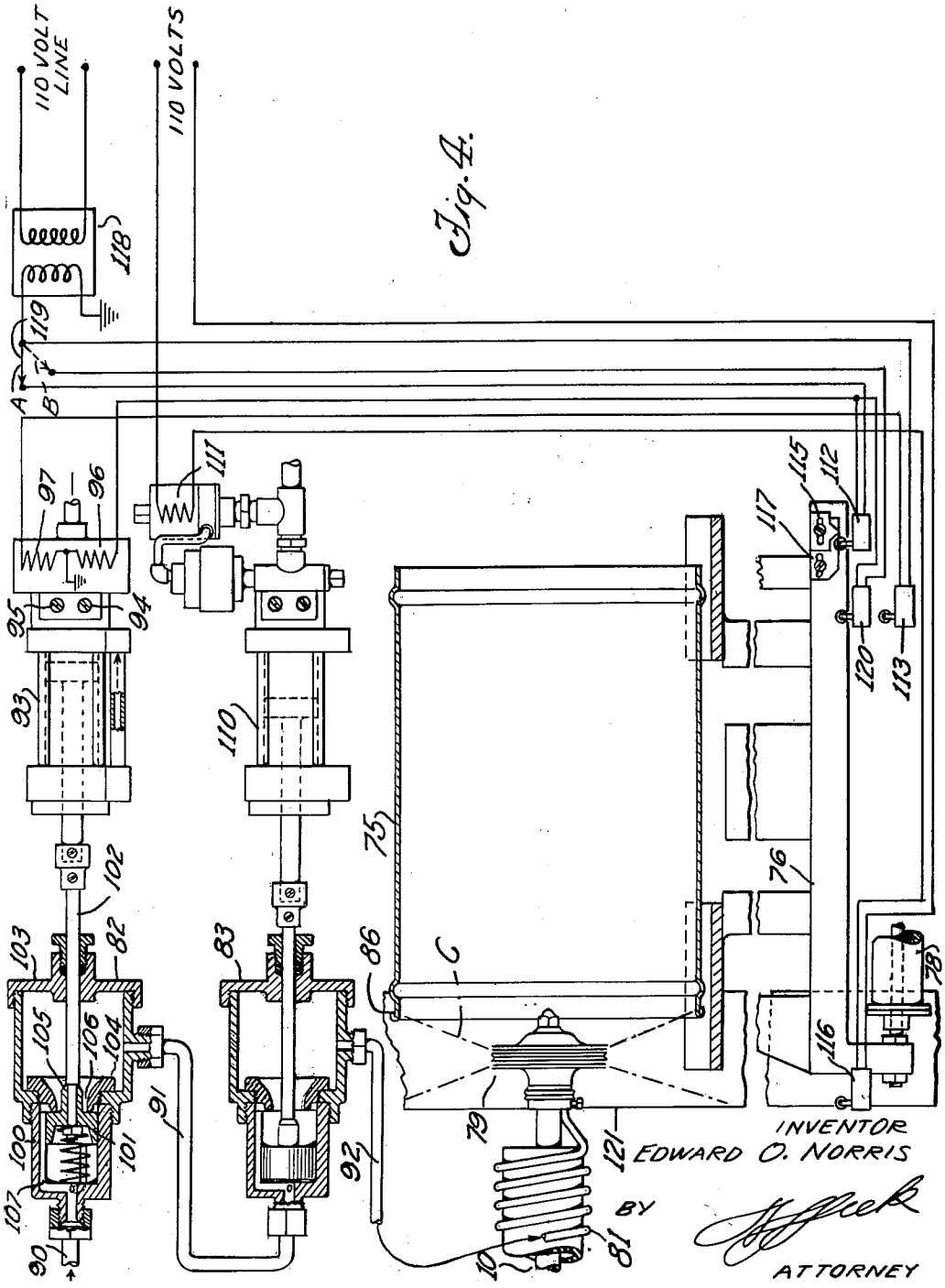


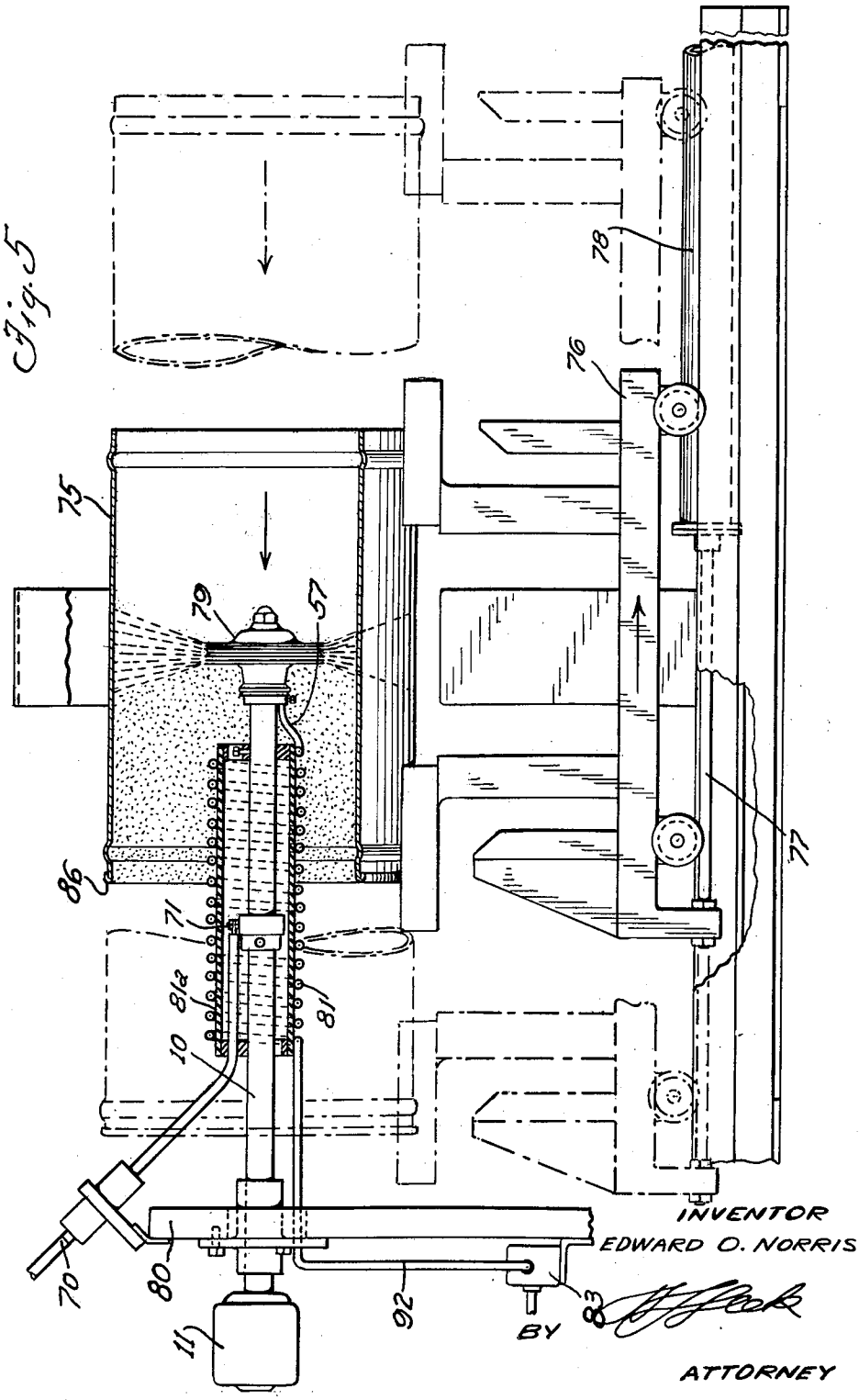
Fig. 4.

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Fig. 5



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3,017,116

ELECTROSTATIC SPRAYING DEVICE

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6 Claims. (Cl. 239—15)

The present invention relates to rotary spraying devices wherein liquid for painting or otherwise coating or treating a surface is fed to an atomizing distributor head operating at high speed, and is atomized and projected by said distributor head in the form of an annular or fan shaped spray against the surface to be sprayed. The present invention is an improvement over the multiple atomizing disc type of centrifugal spray device shown and described in U.S. Patent No. 2,545,488.

One object of the present invention is to provide a new and improved rotary spray device of the multiple atomizing disc type capable of projecting a spray of increased depth along its axis of rotation without materially increasing the size of the device.

A further object is to provide a new and improved rotary spray device, which can be efficiently controlled to vary selectively the concentration and distribution of the material across the depth of the spray.

Another object is to provide a new and improved rotary spray device which can be easily controlled quickly, as for example, for cyclic automatic operations to project a spray of any desired density at any selected periods.

Another object is to provide an automatic method and apparatus by which a spray is applied to articles, such as hollow drum shells, under controls, which stop and start the projection of the spray and/or vary its density at predetermined intervals in accordance with the relative positions of the articles and the spray device.

In accordance with certain features of the present invention, the spray device of the present invention comprises a plurality of rotary atomizer axially spaced dished discs in the form of rings, arranged in two opposed sets, each set consisting of one disc or a plurality of nesting discs, and the concave sides of the discs in the two sets facing axially opposite directions away from each other. A rotary spreader is provided inside the two sets of discs with a discharge edge or rim extending obliquely across the inner annular inlet edges or rims of said discs, to distribute the coating material from said discharge spreader rim to each of said inlet disc rims in predetermined proportions. The inlet edges or rims of the atomizing discs are bevelled or otherwise contoured to assure the required distribution of material delivered to said discs from said spreader.

The atomizer discs have discharge rims flaring in axially opposite directions away from each other in the two sets, so that the spray diverges depthwise along the axis of rotation, thereby assuring a thicker spray for wider impingement stripe coverage and also permitting a wider distribution of the material as to assure a spray of lighter density, where such is required, as for example in connection with the coating of certain contours and shapes to be described.

As a further feature of the present invention, the centrifugal spray device of the multiple atomizer disc type is employed in connection with an electrostatic field to assist and improve the centrifugal coating function of the spray device.

As another feature, in conjunction with the electrostatic field, means are provided to controllably distribute the coating material to each disc in such a manner, that the discs having the strongest field, effect, receive and atomize the greater portion of the material.

As a further feature, to assist and improve the centrifugal coating function of the multiple disc spray device

described when employed in connection with an electrostatic field, the disc assembly is given a convex axial contour with the centrally disposed discs having the largest external diameters and the top and bottom rings the smallest diameters.

As another feature, the discharge edge of the spreader inside the stack of discs is serrated to increase the effective discharge length of said edge, to effect more uniform distribution of the spray material to the discs and to permit control of the rate of feed through a wider range.

Certain types of articles have certain conformations which are difficult to spray properly, especially where automatic operations are involved, without loss of spray material or without over-spraying certain parts of the article. For example, a certain type of drum or tubular shell has an edge or rim section at the top or head end rolled back externally to form a bead or curl. In coating the interior of such a shell, it is also desirable to coat not only the interior of the curled rim but also the exterior. With the drum shell arranged to move axially relative to the spray device and the spray device located inside the shell, it is desirable to apply to the interior surfaces of the drum shell heavy material at a relatively high linear speed of movement between the drum shell and the spray device and also to coat not only the interior of the curled rim but also the exterior. In accordance with the present invention, this result is attained by creating an electrostatic field to cause the spray particles to be electrostatically deflected around the outside of the drum shell and the spray to be wrapped around the curled rim. Since the spray device is operated with a heavy spray for the interior of the drum shell, the application of this heavy spray for the electrostatic "wrap around" has the disadvantage of creating material losses towards the end of the drum shell. Moreover, the heavy particles are more difficult to deflect electrostatically around the curled end of the drum shell.

As another feature of the present invention, means are provided for controlling the rate of feed of material to the spray device cyclically in accordance with the position of said spray device in relation to the drum shell or other article to be sprayed. For example, at or near the ends of the relative travels of the drum shell and the spray device, where there is travel reversal involved, the temporary pause created by such reversal may cause overspray or loss of material, and the feed of material is in accordance with the present invention shut off, or its rate materially reduced by automatic control. Also, where a curled rim at the end of the drum shell is to be externally sprayed, the rate of feed of material to the spray device is reduced when the spray device is in the vicinity of the region of the plane of said curled rim to create a spray of lighter density. The particles in such a spray being smaller and lighter, they are more easily deflected by electrostatic action, so that the spray will wrap around the rim more effectively. This assures proper coating of the interior of the drum shell and also of the outside of the curled rim.

The specific centrifugal spray device of the multiple disc type described above is particularly adaptable for the automatically controlled system described. However, as far as certain aspects of the invention are concerned, any other suitable type of spray device may be employed in connection with the control features described.

Various other objects, features and advantages of the invention are apparent from the following specification and from the accompanying drawings, in which:

FIG. 1 is a longitudinal section through the distributor of a spray device constituting one embodiment of the present invention;

FIG. 2 is a fragmentary view of the distributor of

FIG. 1 shown partily in longitudinal section and partly in elevation;

FIG. 3 is a fragmentary longitudinal section of another form of centrifugal atomizer rings embodying the present invention, and useful especially in connection with the use of an electrostatic field;

FIG. 4 is a diagrammatic illustration of a system involving the automatic control of a spray device in accordance with the present invention, and illustrated in connection with the coating of drum shells to apply protective lining coatings to the interior thereof; and

FIG. 5 is an enlargement of part of the automatic control system illustrated in FIG. 4, and especially the drum shell conveyor means and the position of the spray device in relation thereto.

Referring to FIGS. 1 and 2 of the drawings, the distributor centrifugal spray head is mounted on a fixed tubular housing **10**, which is secured to casing of a motor **11** (FIG. 5) and to the casing of a reduction gearing, if such is employed. Extending axially through the housing **10** is a shaft **12** driven from the motor **11** and supported in said housing by ball bearings **13** and roller bearings **14**. This shaft **12** carries near one end a distributor spray head unit comprising a series of atomizer discs **15, 16, 17, 18** and **19** in the form of rings axially spaced along said shaft and secured to frame pieces **20** and **21** mounted on said shaft. The frame piece **20** forms a cover for one end of the distributor head and comprises a peripheral flat ring section **22** axially spaced from the outer end atomizer disc **19** and parallel thereto and a center dome section **23** with a center hub **24** embracing the outer end of the shaft **12** and seated on an annular shoulder **25** formed on said shaft. A locking nut **26** threaded on the outer end of the shaft **12** and bearing against the cover **20** secures the cover to the shaft for rotation therewith.

The other frame piece **21** serves as a cover for the other end of the distributor spray head and comprises a peripheral flat ring section **27** axially spaced from the inner end atomizer disc **15** and parallel thereto and a center conical section **28** around the housing **10** serving as a splash guard. The atomizer discs **15—19** and the two covers **20** and **21** are secured together as a rotatable unit by means of screw and washer assemblies **30**.

The atomizer discs **15—19** have their main body sections **34** flat and parallel to each other to form passageways **35** between the confronting faces thereof in planes substantially at right angles to their axis of rotation coextensive with the axis *a* of the shaft **12**, and have center coaxial openings centered with respect to the axis of the shaft **12** and all having substantially the same diameter, except for some bevelled contours on the circular edges of said openings to be described. These openings conjointly define around the shaft **12** the inlet cylindrical chamber or eye **36** of the distributor head and located in said chamber is a rotary material spreader **37**. This spreader **37** is rotatably supported on a ball bearing **40** for rotation with the shaft **12** and is in the form of a cup with its concavity facing generally the inner end of the distributor spray head. An annular discharge edge or lip **38** on the spreader **37** serves to deliver and distribute the coating material from the spreader to the atomizer discs **15—19**.

The spreader **37** although rotated by the shaft **12** and with the shaft at the same high angular velocity, has the general plane of its discharge edge **38** inclined in relation to the planes at right angles to the axis *a* of the shaft, so that said discharge edge plane extends across the inner peripheral edges of the stacked atomizer discs **15—19**. Also, the spreader **37** is adjustable about an axis which is tilted in relation to the axis *a* of rotation of the atomizer discs **15—19**, and the general plane of the discharge edge **38** of the spreader is at an angle to the tilted axis other than an angle of 90°, so that adjustable rotation of the spreader about the tilted axis changes the angle of this general edge plane in relation to the general plane of the atomizer discs. Adjustment of this angle of tilt of the general plane of the discharge edge **38** in relation to the axis *a* of the atomizer discs **15—19** is for the purpose to be described.

Referring more specifically to the structure and mount of the spreader **37**, this spreader is supported on the ball bearing **40** as described, and has an annular flange **41** supporting the inner race of this ball bearing. The outer race of the ball bearing **40** is secured to a bearing cap **42** threaded or otherwise made fast to a sleeve **43**, which embraces a collar **44** secured to the end of the tubular housing **10**, as for example, by threading, and which is adjustably secured to said collar by a set screw **45** impinging in a groove **46** in said collar. Although the part of the collar **44** embraced by the sleeve **43** is cylindrical, its axis is inclined in relation to the axis of the shaft **12**, and as indicated by the lines *a* and *b* in FIG. 1 the axis of the sleeve **43** is disposed at an angle to the axis of the spreader **37** as indicated by the lines *b* and *c* in FIG. 1 so that the general plane of the discharge edge **38** of the spreader **37** is tilted at an angle to the plane at right angles to said tilted axis for the adjusting purpose indicated above.

The spreader **37** rotates through bearing **40** about an axis *c* at right angles to the general plane of the discharge edge **38** of said spreader and the axis center of this bearing in the center plane of the bearing at right angles to this axis *c* is on the axis *a* of the shaft **12**. In other words, a plane through the center of the bearing **40** and at right angles to the axis *c* will pass through the intersecting point of said axis *c* and the shaft axis *a*, as shown in FIGS. 1 and 2. This axial arrangement assures against radial displacement of the spreader **37** relative to the atomizer discs **15—19**, as they are rotated in unison.

The spreader **37** is driven from the shaft **12** for rotation therewith. For that purpose, a spring drive is provided comprising a tapering coil spring **50** around the shaft **12** having its smaller end seated in an annular shoulder recess, forming part of said shaft and anchored thereto for rotation therewith. The larger end of this spring **50** bears against a frame wall of the spreader through a metal bearing ring and a washer of friction material, such as leather, to form a yieldable friction drive connection with the spreader.

The spreader **37** because of its tilted position in relation to the general planes of the atomizer discs **15—19**, extends partly into the dome space of the cover **20** and has an annular flange **55** therein defining an annular trough **56** into which the coating material is fed. This coating material is delivered to the trough **56** through a feed tube **57**, which is detachably secured by a screw **58** to a collar **60** fastened to the housing **10** by a set screw **61**. This feed tube **57** terminates in the spreading trough **56** in a nozzle **62** having its end turned in the direction of rotation of the spreader **37**.

The discharge edge **38** forms the outer boundary edge of the trough **56** and the walls **63** of said trough are curved radially outwardly towards said discharge edge to cause coating material delivered to said trough to flow smoothly by centrifugal action along said curved wall towards said discharge edge.

If the spreader discharge edge **38** were continuous, each segment thereof cooperating with the single atomizer disc opposite thereto for discharge to said disc would be comparatively short and the material spread along such a segment would have correspondingly greater concentration therealong. This continuous edge construction cuts down the range of control of the feed material to the atomizer discs **15—19**. In order to equalize the spreading of the coating material along the discharge edge **38** of the spreader **37** more evenly and to afford a greater range of control of the feed rate to the atomizer discs **15—19**, this edge has a series of serrations **64**, serving

to increase the effective discharge length of this spreader edge **38**.

The inclined discharge spreader edge **38** at its high and low regions extend along the inner annular edges **65** of the atomizer discs at the top and bottom of the disc stack, while the intermediate regions of said discharge edge cut across the inner annular edges **65** of the intermediate atomizer discs at a greater angle, this angle increasing as the middle disc of the stack is approached. As a result, there is a tendency for this discharge spreader edge **38** to project more material onto the top and bottom discs of the stack than onto the center discs. To compensate for this tendency, the inner annular edges **65** of the atomizer discs have angular contours shown as single bevels facing the middle plane of the stack and disposed to deflect some of the projected material from the top and bottom disc areas and towards the more central disc areas, and the center atomizer disc **15** has its inner annular edge **65** doubly bevelled to facilitate entry of the material into the field of action of said center disc and to deflect excess material towards the adjoining discs **16** and **18**. This bevel contouring of the inner edges **65** of the atomizer discs **15—19** serves to equalize the distribution of the coating material to these discs.

As another important feature of the present invention, the atomizer discs **15—19** are constructed and arranged to impart a divergent axial spread to the spray particles. For that purpose, the atomizer discs **15—19** are dished or coned shaped and are mounted into two sets, the rings of the two sets being arranged with the concave sides facing axially away from each other, so that the two sets will be back to back. Where increase in the material handling capacity of the spray device is required, each set of discs will consist of more than one atomizer disc, as shown in the present embodiment, and the discs in each set will be nested in spaced relationship.

Referring more specifically to the structure of the atomizer discs **15—19** shown in FIG. 1, five discs are shown for the purpose of illustration, discs **15** and **16** nesting and forming one set, discs **18** and **19** nesting and forming the other set, and the middle disc **17** being bifunctional and belonging to both sets. The discs **15**, **16**, **18** and **19** are provided with flat bases **34** parallel to each other and peripheral conical discharge rims **66** and **67**, the rims **66** of the two atomizer discs **15** and **16** extending parallel to each other and slanting away from the planes of their bases **34** radially outwardly and axially inwardly of the spray head and the rims **66** of the two atomizer discs **18** and **19** slanting away from the planes of their bases **34** radially outwardly and axially outwardly of the spray device. As a result, the atomizer discs of the two sets will be arranged back to back, with their concave sides facing opposite directions away from each other.

The center atomizer disc **17** has a base **34** similar to the bases **34** of the other atomizer discs **15**, **16**, **18** and **19** but has double peripheral conical rims **67** merging at their larger base ends and flaring in opposite directions from the base **34** of said center disc, one of said rims **67** being parallel to the rims **66** of the atomizer discs **15** and **16**, and the other rim **67** being parallel to the rims **66** of the atomizer discs **18** and **19**. This center disc **17** is in effect, therefore, two discs in back to back contact with their concave sides facing axially away from each other.

As a result of the disc construction and arrangement described the spray projected from the peripheries of the atomizer discs **15—19** will diverge axially and therefore will deposit a wider stripe on the article being coated. This will permit the article being coated to be moved relative to the spray device at a greater speed, permits the production of a spray having a lighter density for the purpose to be described, and permits better control of the distribution of the material across the depth of the spray.

To assist centrifugal action in atomizing and directing the spray in the right direction, and to improve in other respects the centrifugal coating function of the spray device, an electrostatic field may be employed. For that purpose, the atomizing discs **15—19** may be of non-conducting material, as for example, nylon, the cover plates **20** and **21** and the locking nut **26** may also be made of non-conducting material, as for example of phenolic composition and the spreader **37** may be made of conductive material and may be connected to a high voltage line to form one side of the electrostatic field, so that the coating material is electrostatically charged as it leaves the peripheral discharge edge or lip **38** of this spreader, to be received and centrifugally atomized by the atomizer discs **17—19**. The other side of the electrostatic field is established where the article to be coated is located, and this article for that purpose, may be grounded or otherwise connected in the circuit of the high voltage line connecting into the spreader **37**.

To connect the spreader **37** to the high voltage line, there is an electrical connection from the source of high voltage through a conductor or electrode **70** to a binding post **71** on the housing **10**, so that the high voltage current is conducted along the housing and/or along the shaft **12**, through the collar **44**, sleeve **43**, bearing cap **42**, bearing **40**, flange **41** to the walls of the annular spreader trough **56** where the particles of coating material are charged.

In the spray device of FIGS. 1 and 2, the discs **15—19** are of a uniform diameter, and if this spray device is employed in connection with an electrostatic field, as described, the electrostatic field will have the greatest concentration on the discharge peripheries of the outer (top) and inner (bottom) discs **15** and **19**. This variation in the concentration or strength of the electrostatic field can be compensated for by adjusting the angle of the spreader **37** in relation to the general planes of the atomizer discs **15—19**, so that greater proportions of the material is handled by these inner and outer discs. This adjustment can be effected by loosening the screw **45** and turning the spreader **37** about the collar **44** until the spreader tilts in the direction to attain the desired distribution to the disc. In the position in which the bearing **40** of the spreader **37** has its axis along the line *c*, the angle of the spreader will be near its limit, and the inner and outer atomizer discs **15** and **19** will receive a greater proportion of the coating material. To decrease the proportion of coating material received by these inner and outer atomizer discs **15** and **19**, the spreader **37** will be adjusted at a lesser angle, for example, at an angle at which the axis of the bearing **40** is along the line *b*.

The angle adjusting features of the spreader **37** are also useful in connection with spray devices not having electrostatic assistance, to distribute the material to the different atomizer discs in the desired proportions.

As indicated above, in the embodiment of FIGS. 1 and 2, where the discs are all of the same diameter, the distribution of the electrostatic field on the disc peripheries may be uneven, the peripheries of the inner and outer discs **15** and **19** attaining greater concentration. FIG. 3 shows a modified form of spray device in which a more uniform electrostatic field distribution on the disc peripheries is attained. In this construction, the atomizer discs **15*a***, **16*a***, **17*a***, **18*a*** and **19*a*** are similar to the discs in the construction of FIGS. 1 and 2 and are similarly arranged, except that the external diameters of the discs very, increasing progressively from the inner and outer discs **15*a*** and **19*a*** to the centrally disposed ones **17*a***, so that the disc stack has a convex axial contour on its periphery with the centrally disposed disc having the largest external diameter and the inner and outer discs **15** and **19** the smallest diameter.

FIGS. 4 and 5 show an automatic commercial system, in which the multiple disc type of spray device shown in

FIGS. 1–3 may be applied. For purposes of illustration, there is shown a tubular shell and more specifically a common form of drum shell **75**, which may have a capacity of about 55 gallons, and which in most present mill operations is coated internally with a protective lining material before the top and bottom heads are attached. This drum shell **75** is supported horizontally on a wheeled carriage **76**, riding on tracks **77** and moved back and forth axially of the shell through one spraying cycle by any suitable means, as for example, an air cylinder **78**. The drum shell **75** is moved axially in one direction past the field of operation of a spray head **79** located axially of the shell, so that said shell passes over the spray head to expose the inner surface of the shell to the coating action of the spray from said device. At the end of one stroke, in which the shell **75** has traversed a distance equal substantially to its own length during which travel the full length of said shell has been subjected to the spraying action of the spray head **79**, the carriage **76** is reversed to carry the drum shell past the field of operation of the spray head for the full length of the drum shell, whereupon the drum shell **75** is rolled off the carriage and replaced by the next drum shell **75** to be internally coated.

The spray head **79** is illustrated as being similiar to that shown in FIGS. 1–3 and comprises the non-rotatable housing **10** supported on a standard **80** and extending along the axis of the drum shell **75** to be coated. This housing **10** connects into the casing of the motor **11** driving shaft **12**, which extends along said housing to the spray head, as described in connection with FIGS. 1 and 2. A supply tube **81** connected to solenoid valves **82** and **83** and thence to a material supply source under pressure is shown spirally wrapped around a non-conducting sleeve **81***a* and connecting or merging into the feed tube **57** of FIGS. 1–3, to deliver the coating material under pressure to the spreader **37**. This spiral wrapping of the supply tube **81** insures adequate conduit length between the high voltage charged atomizer in the distributor head and the grounded solenoid valve **83**, when materials having some electrical conductivity are being handled, so that the charges are not carried back to the solenoid valve with enough strength to interfere with its proper operation.

The insulated high voltage line or electrode **70** connects to the shaft **12** through binding post **71** in the housing **10** as described, and conducts the charge to the charging point in the spreader **37**, as described. The drum shell **75** is grounded to attract the charged particles of the spray.

The spraying unit illustrated is part of a completely automatic machine in a steel drum line, where the uncoated shells are automatically fed successively onto the carriage **76** at the end of each spray cycle, while the carriage **76** is in the extreme dot and dash line position shown at the right of FIG. 5.

The drum shells **75** are shaped to require special feed controls according to the position of the drum shell in relation to the spray head **79**. The upper rim **86** of most drum shells is curled or rolled over, so that the gasketed cover fits smoothly over this curled rim, and this "curl" should be coated with protecting lining material at least over 75% of its external extent. In accordance with the present invention, this coating of not only the inside of the curled rim **86** but also at least a major part of the outside of the curled rim is achieved while the inside of the drum shell is being coated near its rim end and is effected by automatic control of the feed of the spray material, so that when coating is being carried out in the vicinity of the rim end, the charged particles are small enough and light enough to be deflected by electrostatic action around the rim **86** of the drum shell to the outside thereof. This electrostatic "wrap around" effect of the charged particles causes the outsides of the "curls" to be adequately coated on their outside. The control system to be described is designed to permit periodic variations in the feed of the material during certain coating phases to accomplish the result described.

The two solenoid valves **82** and **83** for controlling the flow of coating material from a supply tank to the distributor head of the spray device with their control circuits are shown in greater detail in FIG. 4. These two valves **82** and **83** are connected in series. Valve **82** has an inlet **90** leading from the supply tank and is of a type to open partly for a predetermined period during energization of its controlling solenoid, to permit a low rate of feed of material therethrough during said period, and said valve **82** has a discharge line **91** connecting to the inlet end of the solenoid valve **83**. This valve **83** is either fully opened or fully closed, but is normally opened, and has an outlet **92** connecting to the supply tube **81**.

The valve **82** is actuated by an air motor **93**, which has an advance speed control screw **94** and a return speed control screw **95** adjustable to give a slow stroke and which is electrically controlled from an advance solenoid **96** and a retract solenoid **97**. The air motor **93**, with its speed controls **94** and **95** and its controlling solenoids **96** and **97**, per se, form no part of the present invention, are well known, and are commercially available, as for example, as Bellows "BEM" Air Motors.

The valve **82** comprises a cylinder **100** having a spring-pressed piston **101** connected to the piston of the air motor **93** by a piston rod **102** and a cylinder **103** of larger diameter than the cylinder **100**, connected thereto and having mounted therein an orifice plate **104** against which the piston **101** seats in closed position of said valve, as shown in FIG. 4. This piston **101** has an axial extension or hub **105** of reduced diameter passing through an orifice **106** of larger diameter in the plate **104** when the valve **82** is in closed position shown. A passageway **107** leads from the inlet end of the cylinder **100** along one side of said cylinder up to the orifice plate **104**, where it is entirely blocked off when the piston **101** is seating against said orifice plate. As the piston **101** is moved towards the left by energization of the advance solenoid **96**, its initial movement may be slow according to the setting of the speed control **94**, and the piston extension **105** will linger in the orifice **106** according to this setting. Under these conditions, the flow through the valve **82** will be restricted to that passing through the annular space between the periphery of this piston extension **105** and the periphery of the orifice **106**, so that the rate of feed of the coating material to the spray head will be correspondingly low. This low feed is desirable during the periods when the spray head is acting in the region of the drum shell **75** where the curled rim **86** is located, to effect the electrostatic "wrap around" of the charged particles as described.

When the piston **101** has moved to the left to the point where its axial extension **105** has emerged from the orifice **106** in the plate **104**, the valve **82** will be fully opened and the flow will be through the fully cleared orifice. The resulting high rate of feed of the material to the spray head **79** is particularly useful during the periods when the interior along the drum shell **75** is being sprayed to effect a heavy deposit on this interior.

The solenoid valve **83** is similar to the solenoid valve **82** except that it has a piston without the axial orifice penetrating extension **105** of valve **82**, so that the valve is either fully opened or fully closed. This valve **83** is controlled from an air motor **110** controlled by a solenoid **111**. The motor **110** and solenoid **111** are of well known construction, and are commercially available, as for example as Bellows "BSKM" Air Motors.

Arranged along the path of movement of the carriage **76** are microswitches **112** and **113** actuated successively by a cam **115** and a microswitch **116** actuated by a cam **117** also carried by said carriage. A supply current stepped down in voltage through a transformer **118** is conducted to either of two loops by a hand switch **119**.

One of these circuit loops containing the microswitches **112** and **113** is connected into the supply circuit when the switch **119** is in the full position A as shown in FIG. 5. For certain types of drum shells or other articles to be coated, it may not be desirable to have the rate of feed vary as described. For that purpose the microswitch **112**, would be rendered in operative by moving the switch **119** from the full line position A shown in FIG. 4, to the dotted position B shown, to disconnect the circuit loop of this microswitch from the current supply line and to connect the other circuit loop into the current supply line. A microswitch **120** in the path of the cam **115** is only in this other circuit loop, and this microswitch serves the purpose to be described. The microswitch **113** is connected to the pivot post of the switch **119**, so that it is connected into both circuit loops.

The microswitch **112** is in the circuit of the advance solenoid **96** and when said switch is closed by the cam **115**, this solenoid is energized and this moves the piston in the air motor **93** towards the left at a speed depending on the setting of the control **94** and starts the valve **82** opening from the closed position shown.

The microswitch **113** is in the circuit of the retract solenoid **97** and when said switch is closed by the cam **115**, the solenoid is energized and this moves the piston in the air motor **93** towards the right at a speed depending on the setting of the control **95** and starts closing the fully opened valve **82** towards the position shown.

The microswitch **116** is in the circuit of the solenoid **111**, and this circuit is independent of those containing the hand switch **119**, so that the operation of this microswitch and this solenoid is not affected by the position of this switch **119**. When the microswitch **116** is closed by the cam **117**, the solenoid is energized and this moves the piston in the air motor **110** towards the left and this fully closes the valve **83**.

The microswitch **120** is in the circuit of the advance solenoid **96** only when the hand switch **119** is in position B, and is actuated by the cam **115** to move the valve **82** into closed position shown to cut off the spray feed.

In operation, the carriage **76** will be in the initial position shown in FIG. 4 with the spray head **79** beyond the rimmed end of the drum shell **75** supported on said carriage. In this initial position of the carriage **76**, any spray C projected from the spread head **79** will have its side nearest the drum shell **75** reaching the vicinity of the adjacent rimmed end of the shell, as shown in FIG. 4. A shield **121** around the spray head **79** and around the drum shell **75** will in this initial position of the carriage **76** catch and drain off the excess part of the spray which does not reach the drum shell. Also, in this initial position of the carriage **76**, the microswitch **112** is so located as to be engaged by the cam **115**, the valve **82** is in completely closed position shown and the valve **83** is in the completely open position shown, so that the spray head **79** has not started to project its spray.

The carriage **76** from the initial position described starts moving the drum shell **75** towards the left, and this immediately causes the cam **115** to close the microswitch **112**, energizing thereby the advance solenoid **96**, assuming that the hand switch **119** is in the position A shown, and causing thereby the piston **101** of the valve **82** to move slowly from the closed position shown in FIG. 4 towards the left. During this first part of this slow valve opening stroke, the piston hub or extension **105** of the valve **82** remains in the orifice **106** of the plate **104**, thereby restricting flow through said orifice, so that the feed of material to the fully opened valve **83** and in turn to the spray head **79** is correspondingly light, creating thereby spray particles which "wrap around" and coat the exterior of the curled rim **86** by electrostatic "wrap around" deflection, as described. This limited feed rate is adjusted by the control **94** as described, to coincide with the period while the spray head **79** is still exterior of the shell. The drum shell **75** then moves over the spray head **79** and simultaneously the axial extension or hub **105** emerges from the orifice **106** of the orifice plate **104**, clearing said orifice and starting a full heavy feed rate of the material, this heavy rate continuing to the end of the travel of the shell travel towards the left. At this point, the right hand end of the shell **75** will be in the region of the spray head **179** and the carriage **76** will start to reverse towards the right.

During the carriage reversal, there is a pause or slowdown in the movement of the shell **75**, which might cause waste of spray material or overspray. To avoid this condition, just as the carriage **76** starts to reverse, the cam **117** reaches and closes the microswitch **116** and this energized the solenoid **111**, thereby actuating the air motor **110** and causing the valve **83** to close and shut off the material feed to the spray head **79** during the initial period of carriage reversal. As the carriage **76** moves for its return stroke towards the right, the cam **117** opens the microswitch **116** and then valve **83** fully opens, causing the heavy feed rate to resume. When the carriage **76** reaches a position near the end of its return stroke towards the right, when the spray head **79** is again in the vicinity of the curled rim **86**, and the shell starts to move away from the spray head, the cam **115** reaches a position to close the microswitch **113**, and this energizes the retract solenoid **97**, causing the piston **101** of the valve **82** to move towards the right from fully opened positions, and causing the piston extension or hub **105** to reenter the orifice **106** of the plate **104**. This action limits the feed rate for a period depending on the setting of the control **95**, thus producing fine, light spray particles, while the spray head **79** is exterior of the shell **75** and is spraying the curled rim **86**. The position of the microswitch **113** is preferably such, that the valve **82** starts to close during return movement at substantially the same position of the carriage **76** that the valve **82** reaches fully opened position during the advance movement of the carriage **76**, and the two controls **94** and **95** are preferably set to afford the same rate of opening and closing the valve **82**.

As the carriage **76** comes to a stop and shell unloading position corresponding to its initial position, the valve **82** reaches a fully closed position, thereby shutting off the feed rate. The drum shell **75** is then automatically unloaded from the carriage **76** and another shell is then rolled onto the carriage for repetition of the cycle.

The above procedure covers the type of operation where the exterior of the curled rim **86** and the interior of the shells **75** have to be coated. However, there are situations where the shells to be lined do not have curled rims. Under these circumstances, the system is adjusted to handle this situation by moving the hand switch **119** from position A to position B and the control screws **94** and **95** are adjusted so that the air motor **93** operates with a fast stroke. With the system so set, the microswitches **113** and **120** will be connected to one current supply line, the microswitch **116** will still be connected to its separate current supply line, and the microswitch **112** will be disengaged from any supply line.

In this type of operation with the switch **119** in position B, the valve **83** fully open and the valve **82** fully closed, the carriage **76** moves from initial position towards the left until the cam **115** engages the microswitch **120** simultaneously with the entrance of the head of the spray head **79** into the shell **75**, thus energizing the advance solenoid **96**, moving the piston in the air motor **93** towards the left and opening the valve **82**. Since the controls **94** and **95** are set for rapid movement of the piston of the air motor **93**, the valve **82** will open fully almost immediately, causing the heavy feed rate to start almost immediately.

When the carriage **76** reaches near the end of its advance stroke towards the left, the cam **117** engaging the

microswitch 116, will close the valve 83 completely and shut off feed to the spray head 79, while the carriage is reversing. After reversal, the microswitch 116 again engaged by the cam 117 will open fully the valve 83, so that heavy feed to the spray device is resumed for the return stroke. When the carriage 76 reaches a position during the return stroke when the shell starts to move away from the spray head 79, the cam 115 engages the microswitch 113 to immediately shut off the valve 82 and thereby completely shut off the feed to the spray head.

In connection with the control systems described, the multidisc distributor head described and shown in FIGS. 1, 2 and 3 are particularly useful. They lend themselves admirably to the type of control contemplated in connection with such a system and produce a wide spray band which permits complete and rapid coverage of the articles being coated. However, as far as certain aspects of the invention, other types of spray devices may be employed in connection with the types of control system described.

While the invention has been described with particular reference to specific embodiments, it is to be understood that it is not to be limited thereto, but is to be construed broadly and restricted solely by the scope of the appended claims.

What is claimed is:

1. A spray head comprising a plurality of rotary atomizer discs axially spaced and having outer peripheral discharge rims, said discs being in the form of rings having central openings conjointly defining a chamber, a rotary spreader in said chamber having an annular peripheral discharge edge, means adjustably supporting said spreader in said chamber permitting the angularity of the general plane of said peripheral discharge edge to be adjusted in relation to the axis of said discs, and means for feeding liquid material to said spreader.

2. A spray head comprising a plurality of rotary atomizer discs axially spaced and having outer peripheral discharge rims, said discs being in the form of rings having central openings conjointly defining a chamber, a rotary spreader in said chamber having an annular discharge serrated edge extending generally diagonally across the inner peripheral edges of the discs and adapted to discharge material and distribute material to the inner peripheral edges of said discs, and means for feeding liquid material to said spreader.

3. A spray head comprising a plurality of atomizer discs axially spaced and having peripheral discharge rims, said discs being in the form of rings with center openings conjointly defining a chamber, a shaft passing through said openings, means connecting said discs to said shaft for rotation therewith, a spreader in said opening supported on said shaft for rotation therewith and having an end wall defining an annular trough with its open end facing an axial direction away from the outer end of the spray head, said trough having an annular discharge edge extending generally diagonally across the inner peripheral edges of said discs, and a feed tube passing through the open end of said trough into said trough for delivering liquid material thereto.

4. A spray head comprising a plurality of rotary discs axially spaced and having outer peripheral discharge rims, means for feeding and distributing liquid material to said discs, said discs being in the form of rings having respective center openings conjointly defining a chamber, said material feeding means comprising a rotary spreader in said chamber adapted to project and distribute the material to the inner peripheral edges of said discs, said spreader being made of conductive material, said discs being made of non-conductive material, and electrical charging means comprising means for conducting an electric current to the spreader to electrically charge the particles of the material in said spreader.

5. A spray head comprising a plurality of rotary atomizer discs axially spaced in a stack and having outer peripheral discharge rims, the central discs having a greater external diameter than the outer discs of said stack whereby the outer peripheral surfaces of said discs conjointly define a convex axial contour, means for feeding and distributing liquid material to said discs, and means for electrically charging the particles of the material to effect electrostatic discharge of the spray from said discs.

6. A spray head comprising a plurality of rotary atomizer discs in the form of rings axially spaced in a stack and having outer peripheral discharge rims and having center openings conjointly defining a chamber, a rotary spreader in said chamber for discharging material and distributing said material to the inner peripheral edges of said discs, the discs near the ends of said stack having their inner peripheral edges bevelled to face toward the center of the stack to deflect the material discharged thereon towards the more centrally placed discs, and means for feeding liquid material to said spreader.

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